SNS Linac Technical Memo

D-Plate, Emittance Measurement; Collector Outgassing Rate

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WBS 14.5.2.8 (Diagnostics – D-Plate, Emittance)

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Vacuum Loads for SNS D-Plate: Emittance Measurement;  Slit
Summary :  In order to do the initial design of the D-plate
vaccuum system a calculation was done to estimate the out-
gassing load from the collector.  Also note that as the
designs of these devices become more mature, the
responsible person should update these values and pass the
information on to the vacuum system designers.
The assumptions made were:
     Device is mounted on a linear actuator similar to the
wire scanner design.
     The slit itself is made from a copper backed graphite
plate.

Conclusion
The estimated out-gassing rate for the slit is 7.617 x 10^-
7 torr*L/s

Inner surfaces exposed to vacuum:
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$d := 2.5 \cdot in$

$t_C := .06 \cdot in$

$t_{Cu} := .25 \cdot in$

$C_{slit} := \dfrac{\pi \cdot d^2}{4} + \pi \cdot t_C \cdot d$

$Cu_{slit} := \dfrac{\pi \cdot d^2}{4} + \pi \cdot t_{Cu} \cdot d$

$Cu_{slit} = 44.337 \, cm^2$

$C_{slit} = 34.709 \, cm^2$

$Guide\_rail_{SA} := 19.91 in^2$

$\text{Guide\_rail}_{SA} = 128.451 \, \text{cm}^2$

$\text{Support}_{SA} := 84.1 \cdot \text{in}^2$

$\text{Support}_{SA} = 542.58 \, \text{cm}^2$

$\text{Tube}_{SA} := \pi \cdot (.625 \cdot \text{in} + .375 \cdot \text{in}) \cdot 14.2 \text{in}$

$\text{Tube}_{SA} = 287.81 \, \text{cm}^2$

$\text{Bellows}_{SA} := \frac{\pi}{4} \cdot \left[(2.2 \cdot \text{in})^2 - (1.04 \, \text{in})^2 \right] \cdot 12.2$

$\text{Bellows}_{SA} = 457.058 \, \text{cm}^2$

Estimate the total amount of copper exposed to the vacuum

$d_{tubing} := 0.25 \cdot \text{in}$

$L_{tubing} := 36 \cdot \text{in}$

$Cu_{tubing} := \pi \cdot d_{tubing} \cdot L_{tubing}$

$Cu_{tubing} = 182.415 \, \text{cm}^2$

$Cu_{total} := Cu_{slit} + Cu_{tubing}$

$Cu_{slit} = 44.337 \, \text{cm}^2$

Leak rate of Copper

$LR_{Cu} := 1 \cdot 10^{-10} \cdot \frac{\text{torr} \cdot L}{s \cdot \text{cm}^2}$

Total outgassing due to copper

$OGR_{Cu} := Cu_{total} \cdot LR_{Cu}$

$OGR_{Cu} = 2.268 \times 10^{-8} \, \frac{\text{torr} \cdot L}{s}$

Outgassing rate of exposed stainless steel surfaces
Outgassing rate of stainless steel

$LR_{ss} := 1 \cdot 10^{-10} \cdot \frac{\text{torr} \cdot L}{s \cdot \text{cm}^2}$

$OGR_{ss} := LR_{ss} \cdot \left(\text{Guide\_rail}_{SA} + \text{Support}_{SA} + \text{Tube}_{SA} + \text{Bellows}_{SA} \right)$

$OGR_{ss} = 1.416 \times 10^{-7} \, \frac{\text{torr} \cdot L}{s}$

Outgassing rate of exposed carbon surfaces
Outgassing rate of carbon

$$LR_C := 1.7 \cdot 10^{-8} \cdot \frac{torr \cdot L}{s \cdot cm^2}$$

$$OGR_C := LR_C \cdot C_{slit}$$

$$OGR_C = 5.901 \times 10^{-7} \frac{torr \cdot L}{s}$$

Seals and their leak rates

$$Bellows := 2 \cdot 10^{-9} \cdot \frac{torr \cdot L}{s}$$

$$conflat := 1 \cdot 10^{-10} \cdot torr \cdot \frac{L}{s}$$

$$viton := 5 \cdot 10^{-9} \cdot torr \cdot \frac{L}{s}$$

Total out-gassing rate of the slit system is:

$$OGR_{ws} := OGR_{ss} + OGR_{Cu} + OGR_C + Bellows + 4 \cdot conflat + viton$$

$$OGR_{ws} = 7.617 \times 10^{-7} \frac{torr \cdot L}{s}$$